National *Semiconductor*

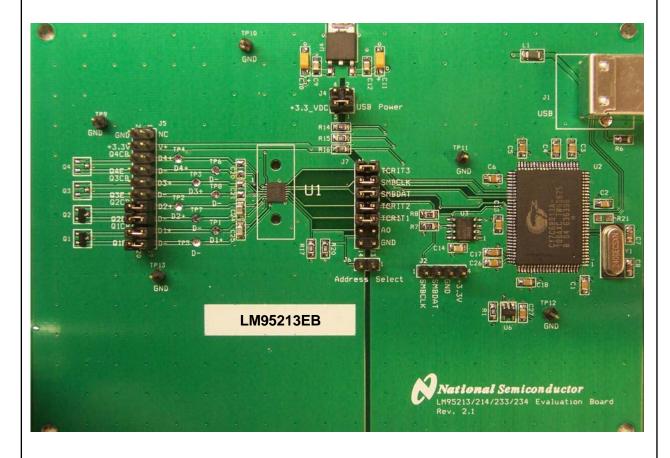Revision C
February 14, 2008

LM95213/14/33/34 Evaluation Board User's Guide

LM95213/14/33/34 Evaluation Board User's Guide
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LM95213/14/33/34 Evaluation Board User's Guide

References

"LM95213/14/33/34 TruTherm™ Precision Dual Remote Diode Temperature Sensor With SMBus Interface" datasheet.

The latest copy of the LM95213/14/33/34 datasheet can be obtained by going to the National Semiconductor website www.national.com, by searching on "LM95213/14/33/34", and then downloading the LM95213/14/33/34.pdf file.

1. SensorEval Version 1.1.0k or later, Evaluation Board CD containing:
   a. The SensorEval.exe executable program used to run the LM95213/14/33/34 Evaluation Board.
   b. A softcopy of this User's Guide
   c. A readme.txt file with useful information about the program.
   d. A softcopy of the SensorEval Software manual.

1.0 Introduction

The LM95213/14/33/34 Evaluation Board is used together with the National Semiconductor SensorEval software (provided in the kit), and with a USB cable (not provided in the kit), and with an external personal computer (PC). Power to the LM95213/14/33/34 Evaluation Board is provide by the +5 VDC line of the USB connection. No external power supply or signal sources are required for operation of the LM95213/14/33/34 evaluation board.

Before connecting the PC to the LM95213/14/33/34 evaluation board through the USB cable, the PC is first turned on and allowed to go through its boot-up procedure. The user installs and initiates the SensorEval software. See Section 4.0 for details.

After the SensorEval software is running, the user can connect the USB cable first to the computer and then to the LM95213/14/33/34 Evaluation Board.

The PC should be able to recognize the board and the user simply selects the LM95213/14/33/34 Eval Board radio button.

The block diagram below describes the LM95213/14/33/34 Evaluation Board itself. The USB input provides the +5.0 VDC power to the board, which is regulated down to 3.3 VDC to power the IC's. The EEPROM is programmed at the factory with a unique ID code for this particular board. When the USB cable is plugged in, the PC interrogates the USB devices and can identify this device as the LM95213/14/33/34 Evaluation Board.

The microcontroller on the board provides the serial SMBus clock (SMBCLK), provides the SMBus data (SMBDAT) signal, and relays the information from the LM95213/14/33/34 to the PC via the USB lines.

The block in the lower right of the Block Diagram shows the signals that are available to probe by the user for either of the LM95213/14/33/34 devices on the board.

1.1 Block Diagram

2.0 Quick Start

1. Install the CD into the CD drive of the computer and install the SensorEval software (see Section 4.0).

2. Hookup the USB cable between the PC or notebook computer and the LM95213/14/33/34EVAL board as shown in Quick Start Diagram below.

3. Run the SensorEval software clicking the icon on the desktop. The first screen after the installation will look like this:

Open Device

Look in: device

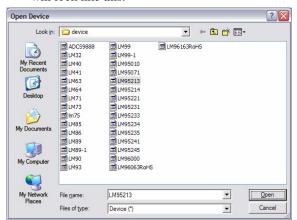| My Recent Documents	ADCS9888	LM99	LM96163RoHs
	LM32	LM99-1	
Desktop	LM40	LM95010	
	LM41	LM95071	
	LM63	LM95213	
My Documents	LM64	LM95214	
	LM71	LM95221	
	LM73	LM95231	
My Computer	lm75	LM95233	
	LM85	LM95234	
	LM86	LM95235	
My Network Places	LM89	LM95241	
	LM89-1	LM95245	
	LM90	LM96000	
	LM93	LM96063RoHs	

File name: LM95213   Open
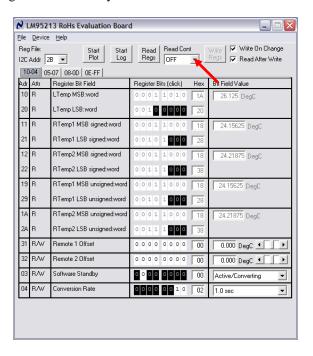Files of type: Device (*)   Cancel
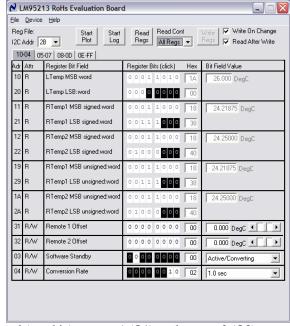
Select LM95213/14/33/34 and click on Open button.

4. The next screen (first screen after the first run of the program) will look like this if the LM95213 is selected:

LM95213 RoHs

Select the desired hardware

- (•) LM95213 RoHs Evaluation Board
- ( ) LM95213 RoHs ICHx Interface
- ( ) LM95213 RoHs No Hardware

OK   Another Device

In this example we would select the LM95213 RoHS Evaluation Board.
Click OK.

5. The next screen will look like this: In the box "Read Cont" and "All Regs" to read the temperature registers continuously.

LM95213 RoHs Evaluation Board

File Device Help

Reg File: Start Plot Start Log Read Regs Read Cont [OFF] Write Regs ☑ Write On Change ☑ Read After Write
I2C Addr 2B

Tabs: 10-04 05-07 08-0D 0E-FF

Adr	Attr	Register Bit Field	Register Bits (click)	Hex	Bit Field Value
10	R	LTemp MSB:word	0 0 0 1 1 0 1 0	1A	26.125 DegC
20	R	LTemp LSB:word	0 0 1 0 0 0 0 0	20	
11	R	RTemp1 MSB signed:word	0 0 0 1 1 0 0 0	18	24.15625 DegC
21	R	RTemp1 LSB signed:word	0 0 1 0 1 0 0 0	28	
12	R	RTemp2 MSB signed:word	0 0 0 1 1 0 0 0	18	24.21875 DegC
22	R	RTemp2 LSB signed:word	0 0 1 1 1 0 0 0	38	
19	R	RTemp1 MSB unsigned:word	0 0 0 1 1 0 0 0	18	24.15625 DegC
29	R	RTemp1 LSB unsigned:word	0 0 1 0 1 0 0 0	28	
1A	R	RTemp2 MSB unsigned:word	0 0 0 1 1 0 0 0	18	24.21875 DegC
2A	R	RTemp2 LSB unsigned:word	0 0 1 1 1 0 0 0	38	
31	R/W	Remote 1 Offset	0 0 0 0 0 0 0 0	00	0.000 DegC ◄ ►
32	R/W	Remote 2 Offset	0 0 0 0 0 0 0 0	00	0.000 DegC ◄ ►
03	R/W	Software Standby	0 0 0 0 0 0 0 0	00	Active/Converting
04	R/W	Conversion Rate	0 0 0 0 0 0 1 0	02	1.0 sec

6. The Screen should look like this:

LM95213 RoHs Evaluation Board

File Device Help

Reg File: Start Plot Start Log Read Regs Read Cont [All Regs] Write Regs ☑ Write On Change ☑ Read After Write
I2C Addr 2B

Tabs: 10-04 05-07 08-0D 0E-FF

Adr	Attr	Register Bit Field	Register Bits (click)	Hex	Bit Field Value
10	R	LTemp MSB:word	0 0 0 1 1 0 1 0	1A	26.000 DegC
20	R	LTemp LSB:word	0 0 0 0 0 0 0 0	00	
11	R	RTemp1 MSB signed:word	0 0 0 1 1 0 0 0	18	24.21875 DegC
21	R	RTemp1 LSB signed:word	0 0 1 1 1 0 0 0	38	
12	R	RTemp2 MSB signed:word	0 0 0 1 1 0 0 0	18	24.25000 DegC
22	R	RTemp2 LSB signed:word	0 1 0 0 0 0 0 0	40	
19	R	RTemp1 MSB unsigned:word	0 0 0 1 1 0 0 0	18	24.21875 DegC
29	R	RTemp1 LSB unsigned:word	0 0 1 1 1 0 0 0	38	
1A	R	RTemp2 MSB unsigned:word	0 0 0 1 1 0 0 0	18	24.25000 DegC
2A	R	RTemp2 LSB unsigned:word	0 1 0 0 0 0 0 0	40	
31	R/W	Remote 1 Offset	0 0 0 0 0 0 0 0	00	0.000 DegC ◄ ►
32	R/W	Remote 2 Offset	0 0 0 0 0 0 0 0	00	0.000 DegC ◄ ►
03	R/W	Software Standby	0 0 0 0 0 0 0 0	00	Active/Converting
04	R/W	Conversion Rate	0 0 0 0 0 0 1 0	02	1.0 sec

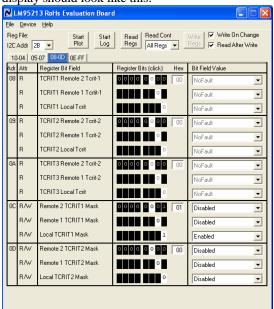Local (on-chip), remote 1 (Q1), and remote 2 (Q3), etc. temperatures will be updated continuously.

7. The user may then experiment by selecting tabs associated with logically-grouped sets of registers for the device. The default is the first tab for registers 10-04hex. For example, for this tab the user can select a different Conversion Rate (Register 04h).

8. Selecting the next tab, for registers 05–07, the display should look like this:

LM95213 RoHs Evaluation Board — tab 05-07

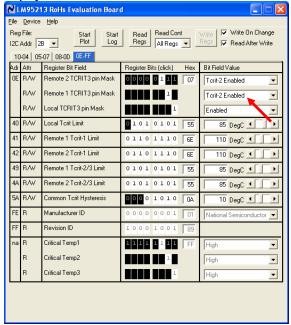| Adr	Attr	Register Bit Field	Register Bits (click)	Hex	Bit Field Value
05	R/W	Remote 2 Temp Conversion	0 0 0 0 0 1 1 1	07	Enabled
	R/W	Remote 1 Temp Conversion	1		Enabled
	R/W	Local Temp Conversion	1		Enabled
06	R/W	Remote Channel 2 Filter	0 0 0 0 1 1 1 1	0F	Enhanced Enabled
	R/W	Remote Channel 1 Filter	1 1		Enhanced Enabled
0F	W	One Shot Conversion	0 0 0 0 0 0 0 0	00	
02	R	Converting	0 0 0 0 0 0 0 0	00	Not Busy
	R	Not Ready	0		Ready
	R	Status Register 4 Flag	0		NoFault
	R	Status Register 3 Flag	0		NoFault
	R	Status Register 2 Flag	0		NoFault
	R	Status Register 1 Flag	0		NoFault
07	R	Remote 2 Diode Open Fault	0 0 0 0 0 0 0 0	00	NoFault
	R	Remote 2 Diode Short Fault	0		NoFault
	R	Remote 1 Diode Open Fault	0		NoFault
	R	Remote 1 Diode Short Fault	0		NoFault

Register 07h will show remote diode shorts or opens as "fault".

9. Selecting the next tab, for registers 05–07, the display should look like this:

LM95213 RoHs Evaluation Board — tab 08-0D

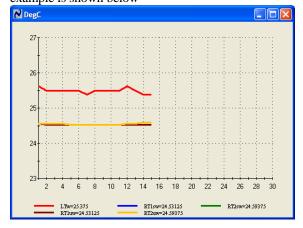| Adr	Attr	Register Bit Field	Register Bits (click)	Hex	Bit Field Value
08	R	TCRIT1 Remote 2 Tcrit-1	0 0 0 0 0 0 0 0	00	NoFault
	R	TCRIT1 Remote 1 Tcrlt-1	0		NoFault
	R	TCRIT1 Local Tcrit	0		NoFault
09	R	TCRIT2 Remote 2 Tcrit-2	0 0 0 0 0 0 0 0	00	NoFault
	R	TCRIT2 Remote 1 Tcrit-2	0		NoFault
	R	TCRIT2 Local Tcrit	0		NoFault
0A	R	TCRIT3 Remote 2 Tcrit-2	0 0 0 0 0 0 0 0	00	NoFault
	R	TCRIT3 Remote 1 Tcrit-2	0		NoFault
	R	TCRIT3 Local Tcrit	0		NoFault
0C	R/W	Remote 2 TCRIT1 Mask	0 0 0 0 0 0 0 1	01	Disabled
	R/W	Remote 1 TCRIT1 Mask	0		Disabled
	R/W	Local TCRIT1 Mask	1		Enabled
0D	R/W	Remote 2 TCRIT2 Mask	0 0 0 0 0 0 0 0	00	Disabled
	R/W	Remote 1 TCRIT2 Mask	0		Disabled
	R/W	Local TCRIT2 Mask	0		Disabled

In order to test the operation of the TCrit pins the mask for the TCrit pin to be tested needs to be disabled.

10. Selecting the next tab, for registers 0E–FF, the display should look like this:

LM95213 RoHs Evaluation Board — tab 0E-FF

Adr	Attr	Register Bit Field	Register Bits (click)	Hex	Bit Field Value
0E	R/W	Remote 2 TCRIT3 pin Mask	0 0 0 0 0 1 1 1	07	Tcrit-2 Enabled
	R/W	Remote 1 TCRIT3 pin Mask	1		Tcrit-2 Enabled
	R/W	Local TCRIT3 pin Mask	1		Enabled
40	R/W	Local Tcrit Limit	0 1 0 1 0 1 0 1	55	85 DegC
41	R/W	Remote 1 Tcrit-1 Limit	0 1 1 0 1 1 1 0	6E	110 DegC
42	R/W	Remote 2 Tcrit-1 Limit	0 1 1 0 1 1 1 0	6E	110 DegC
49	R/W	Remote 1 Tcrit-2/3 Limit	0 1 0 1 0 1 0 1	55	85 DegC
4A	R/W	Remote 2 Tcrit-2/3 Limit	0 1 0 1 0 1 0 1	55	85 DegC
5A	R/W	Common Tcrit Hysteresis	0 0 0 0 1 0 1 0	0A	10 DegC
FE	R	Manufacturer ID	0 0 0 0 0 0 0 1	01	National Semiconductor
FF	R	Revision ID	1 0 0 0 1 0 0 1	89	
na	R	Critical Temp1	1 1 1 1 1 1 1 1	FF	High
	R	Critical Temp2	1		High
	R	Critical Temp3	1		High

In order to check the TCrit outputs you should make sure that the Mask is Disabled for the Local/Remote and TCrit Pin you wish to test (Red Arrow)
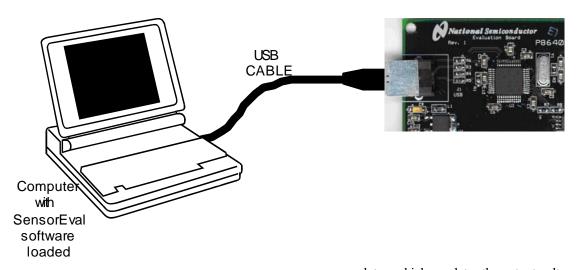
11. If the user clicks on the Start Plot button a graph box will appear and will graph the temperature. An example is shown below

Graph (DegC): LTsw=25.375, RT1sw=24.53125, RT2sw=24.59375, RT1uw=24.53125, RT2uw=24.59375

12. Clicking on the Start Log button will allow the user to create a file name and then will start sequence

2.1 Quick Start Diagram

Important! *NO EXTERNAL POWER SUPPLY OR SIGNAL INPUTS ARE REQUIRED!*

USB CABLE

Computer with SensorEval software loaded

3.0 Functional Description

The LM95213/14/33/34 Evaluation Board, along with the SensorEval Software, provides the system designer with a convenient way to learn about the operation of the LM95213/14/33/34 Temperature Sensor chip. The user simply has to install the SensorEval software on his PC, run it, connect the USB cable from the PC to the Evaluation Board, and the user can read the temperatures. It's that simple! The user doesn't have to provide any power or external signals to the evaluation board.

Power to the LM95213/14/33/34 Evaluation Board is taken from the USB 5-Volt line. This +5 VDC is the input to the on-board LM2950 low dropout voltage regulator, which regulates the output voltage to +3.3 VDC. This output voltage powers the LM95213/14/33/34, the on-board microcontroller, and the EEPROM chip where the board ID information is stored.

The microcontroller provides the SMBus Clock (SMBCLK) signal and the SMBus Data (SMBDAT) signal to the LM95213/14/33/34 chip. This communication between the LM95213/14/33/34 and the PC USB data lines is controlled by the microcontroller. For all of the details of this communication protocol see the latest LM95213/14/33/34 datasheet, available at www.national.com.

3.1 LM95213/14/33/34 Evaluation Board Connection Table

Connector Label	Pin Number	Description
J1	N/A	USB Cable Input. Connect the USB cable to this jack *after* the SensorEval software has been loaded on the PC.
J2 Output header provides user with signals for test purposes only. (may not be stuffed) *Do not apply any external power or signals to any of the pins on these headers!*	1	SMBCLK. Clock signal for SMBus.
	2	SMBDAT. Data signal for the SMBus.
	3	GND. System ground.
	4	V_{DD}. The +3.3 VDC voltage supplied by the on-board voltage regulator to the LM95213/14/33/34 V_{DD} input pin. **Do not connect an external power supply to this pin!**
J4 USB Power	1, 3	Short to connect 3.3V regulator output to LM95213/14/33/35 Power pin
	2, 4	GND connection
J5 Connection to temperature diodes *Do not apply any external power or signals to any of the pins on these headers for normal operation!*	1	Pin 1 of DUT (NC)
	2	GND
	3, 4	+3.3V_DC
	5, 6	Short for D4+ connection to board MMBT 3904 (not available for the LM95213/LM95233)
	7, 8	Short for D4- connection to board MMBT 3904 (not available for the LM95213/LM95233)
	9, 10	Short for D3+ connection to board MMBT 3904 (not available for the LM95213/LM95233)
	11, 12	Short for D3- connection to board MMBT 3904 (not available for the LM95213/LM95233)
	13, 14	Short for D2+ connection to board MMBT 3904
	15, 16	Short for D2- connection to board MMBT3904
	17, 18	Short for D1+ connection to board MMBT3904
	19, 20	Short for D1- connection to board MMBT3904
J6 Address Select	1, 2	Short to connect A0 to GND (note, J7 pins 11 and 12 must also be shorted)
J7 Output header provides user with device digital signals for test purposes only. *Do not apply any external power or signals to any of the pins on these headers for normal operation!*	1, 2	Short to connect TCRIT3 pin to controller circuitry and pullup
	3, 4	Short to connect SMBCLK device signal, clock signal for SMBus, to microcontroller
	5, 6	Short to connect SMBDAT device signal, data signal for SMBus, to microcontroller
	7, 8	Short to connect TCRIT2 pin to controller circuitry and pullup
	9, 10	Short to connect TCRIT1 pin to controller circuitry and pullup
	11, 12	Short to connect A0 pin to mid supply. Note if this pin is open A0 is tied to 3.3V through a pullup resistor.
	13, 14	GND. System ground.

4.0 Software Installation and Operation

4.1 Installation

The CD provided in the LM95213/14/33/34 Evaluation Board Kit contains the SensorEval software used to make the LM95213/14/33/34 Evaluation Board operate with the user's PC. It is assumed that the user will be using a PC with a Pentium® IV or higher processor and Microsoft Windows® XP/2000/ operating system.

 The software is installed as follows:

Insert the SensorEval CD into the CD drive of the PC. See details in the readme.txt file.

The software manual, provided on the CD, may be useful to the user during this process.

Follow all of the Installation instructions in the windows as the SensorEval software is installing.

The installation process will put an icon on the PC desktop so that the SensorEval program will run when the icon is double-clicked.

4.2 Operation

Follow the following procedure for operation the LM95213/14/33/34 Evaluation Board using the SensorEval software:

Run the SensorEval program by either double-clicking on the icon on the desktop or by selecting Start, Program Files, National Semiconductor, National SensorEval.

- Plug in the USB cable on both the PC and the LM95213/14/33/34 Evaluation Board.

Follow the register setup steps given in section 2.0 Quick Start of this User's Guide. Make sure that you are following the given procedure for the specific evaluation board you are working with.
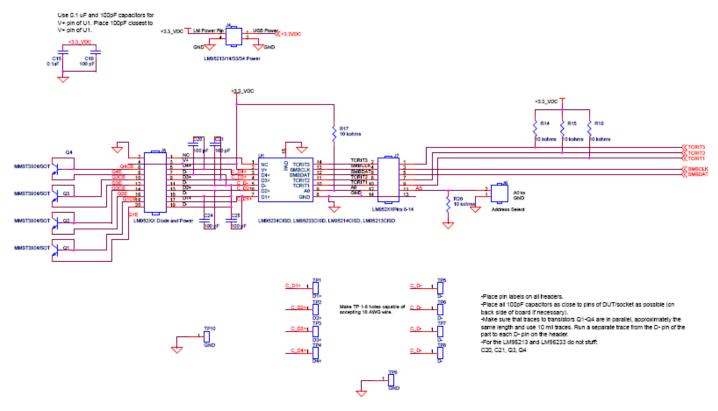
Refer to the electrical schematic, layout and connector diagrams for proper connections to external remote thermal diodes.

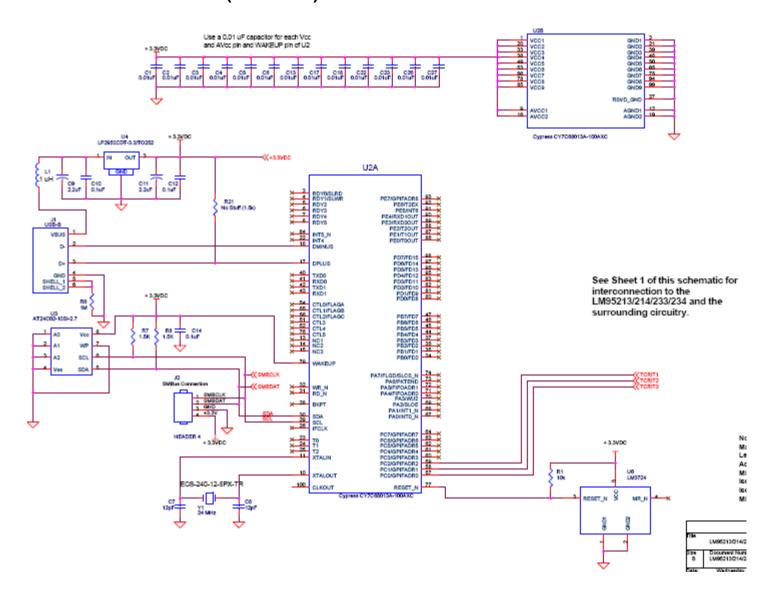# 5.0 Electrical and Mechanical Specifications

5.1 Electrical Specifications

Power Requirements	
The Board uses the +5.0 VDC and GND lines from the USB connection. This +5.0 VDC voltage is regulated down to +3.3 VDC for board power. * **NO EXTERNAL POWER SUPPLY INPUTS ARE REQUIRED** *	+5.0 ± 0.1 V, 100 mA max.

5.2 Electrical Schematic

Page 1 of 2 Pages of the Schematic of the LM95213/14/33/34 Evaluation Board

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5.2 Electrical Schematic (continued)

Page 2 of 2 Pages of the Schematic of the LM95213/14/33/34 Evaluation Board

5.3 Evaluation Board Layout

Figure 5.3 Layout diagram of the LM95213/14/33/34 Evaluation Board

5.4 Bill of Materials for LM95213/14/33/34 Evaluation Board

Item	Quantity	Reference	Part
1	13	C1,C2,C3,C4,C5,C6,C13, C17,C18,C22,C23,C26,C27	0.01uF
2	2	C8,C7	12pF
3	1	C9	2.2uF
4	4	C10,C12,C14,C15	0.1uF
5	1	C11	10uF
6	5	C16,C20,C21,C24,C25	100 pF
7	1	J1	USB-B
8	1	J2	HEADER 4
9	1	J4	LM95213/14/33/34 Power
10	1	J5	LM952XX Diode and Power
11	1	J6	HEADER 2
12	1	J7	LM952XXPins 8-14
13	1	L1	1uH
14	4	Q1,Q2,Q3,Q4	MMBT3904/SOT
15	1	R1	10k
16	2	R4,R3	22
17	1	R6	1M
18	2	R8,R7	1.5K
19	5	R14,R15,R16,R17,R20	10 kohms
20	1	TP1	D1+
21	1	TP2	D2+
22	1	TP3	D3+
23	1	TP4	D4+
24	4	TP5,TP6,TP7,TP8	D-
25	2	TP10,TP9	GND
26	1	U1	LM95234CISD, LM95233CISD, LM95214CISD, LM95213CISD
27	1	U2	Cypress CY7C68013A-100AXC
28	1	U3	AT24C02-10SI-2.7
29	1	U4	LP2950CDT-3.3/TO252
30	1	U6	LM3722
31	1	Y1	24 MHz Crystal

5.5 Mechanical Specifications

5.5.1 Operating Mechanical and Environmental Specifications

	Minimum	Typical	Maximum
Temperature	0°C	25°C	70°C

5.5.2 Evaluation Board Basic Dimensions

5.20 in (13.2 cm) x 3.70 in (9.40 cm)

5.5.3 Electrostatic Discharge (ESD) Precautions

The user shall use standard industry-wide ESD precautions, including properly installed and properly grounded wrist straps, when using these evaluation boards.

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